REPORT

of

COMMITTEE ON EXAMINATION

This is to certify that we the undersigned, as a Committee of the Graduate School, have given John Charnley McKinley final oral examination for the degree of Master of Arts. We recommend that the degree of Master of Arts be conferred upon the candidate.

Minneapolis, Minnesota

May 31 1917

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REPORT

of

Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by John Charnley McKinley for the degree of Master of Arts. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts.

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Observations on the Muscular System of the Human Newborn Infant.

A Thesis

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J. Charnley McKinley

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Observations on the Muscular System of the Human Newborn Infant.

J. C. McKinley.

I. Introduction.

It is a well known fact that the anatomy of the fetus and child has been only very incompletely worked out up to this time. A review of the literature shows that the muscular system has been particularly neglected; in general, such observations as have been made have not been undertaken with the view of giving a description of the myology of the fetus and child, but rather have been incedental to work on comparative anatomy, anthropology and the like. This paper, then, is intended to be a description of some of the facts of the normal newborn baby in regard to the musculature. It is, of course, understood that a description of the muscular system of three or four babies is only partially valuable in establishing a norm for such a variable individual as the human infant; but it is a start, at least, in a field where practically nothing has been attempted.

II. Literature.

The following literature citations are arranged in chronological order without any attempt to group them according to the region on which the author worked, because they are so few and so varied in their topics that they do not lend themselves to classification. References have been made to papers which do not show any very great bearing on the general subject in hand. The reason for referring to such articles is that the literature is so scarce that even those that are only faintly relative to the musculature of the newborn are of interest in a consideration of this problem.

Burns ('23) makes the following remarks in regard to a child of twelve months:

"The sterno-mastoid muscle and the omo-hyoideus decussate each other two finger-breadths above the clavicle, and three below the angle of the jaw------".

"In summing up the differences in the relation of the parts between the chin and the shoulder in the adult and the young subject we are----- led, in the latter, to notice ----- the immense space between the jaw and the angle of decussation of the omo-hyoideus and the sterno-mastoid muscle".

Bourgery and Jacob ('54) figure, without description, the musculature of the superior and inferior extremity in the newborn. The plate shows general agreement with the topography of the models made in the course of this investigation.

Williams ('79) states that the reflected head of the M. rectus femoris is the true continuation of the main tendon of origin while the iliac head is merely accessory. In establishing his point he says:

"This view also receives confirmation from the examination of the muscle in the fetus. At about the sixth month only the acetabular head can be distinguished. The iliac head cannot be discriminated from the fascia of the part. At full term the acetabular head is as large as the main tendon, of which it is obviously the direct continuation; whilst the iliac head, though plainly visible, is relatively insignificant".

"Mr. Hensman has called my attention to the fact, that in the flexed condition of the fetal limb the acetabular head is not bent; it is then in a straight line with the rest of the muscle".

Dalla Rosa ('86) discusses the development of the M. temporalis from the stage of the newborn infant to that of the adult. He carries his work through by means of extremely detailed measurements. He states that the muscle is relatively small in the newborn baby in comparison with the adult. His conclusions in this connection are interesting:

"Bei dem Wachstum des menschlichen Schläfenmuskels sind also zwei Momente auseinander zu halten: einmal die Zunahme seiner Flächenausdehnung, welche adäquat ist dem Wachstum der Schädelkapsel; dann aber ein gewisses selbständiges, progressives Wachstum, durch welches er seine Intertionsgrenzen (Insertionsgrenzen ?) an der Seitenwand des Schädels ausbreitet".

Berkenbusch ('90), in spite of the suggestive title of his article, Die innern Proportionen des menschlichen Halses in den verschiedenen Lebensaltern und die Fascienverhältnisse dieses Körperteils, records nothing on the musculature of the child or newborn baby, but merely gives a few statements in regard to the muscle relationships without reference to the age of his material.

Schäffer ('92) makes the following observations on the weight and color of the musculature of the newborn baby:-

"Das Gesammtgewicht der Muskulatur eines ausgetragenen Neugeborenen beträgt 625 gr., das zugehörige Skelett 445 gr., d.h. etwa 23.3 bezw. 16.7 Prozente des Körpergewichtes ------. Die foetalen Muskeln sind weit blasser als diejenigen Erwachsener. Einen Unterschied beobachtete ich zwischen einem 42 cm langen, sub partu verstorbenen Kinde und einem 51 cm langen, welches 5 Tage gelebt hatte: die Muskeln des ersteren waren blass, des letzteren röthlich".

Blum ('94), working on the coccygeal musculature to establish the presence of not only the M. coccygeus, but also a M. sacrococcygeus anterior, and a sacrococcygeus posterior, touches incidentally on the conditions in the fetus and the young child. He says little in regard to these stages but leads one to believe that he suspects an occasional occurence of these two muscles here as well as in the adult. He states that the M. coccygeus is present exactly as in the adult ("der M. coccygeus ----- sich genau in der gleichen Weise verhielt, wie beim Erwachsen").

Popowsky ('99), in his article on the development of the muscles of the perineum, states that the M. transversus perinei is not differentiated until about the time of birth or after.

Haberer ('00) makes the following observations in regard to the cranial attachment of the M. rectus capitis anticus major (M. longus capitis,- B.N.A.) and the M. rectus capitis anticus minor (M. rectus capitis anterior,- B.N.A.) in the embryo and newborn baby:

"Bei Embryonen aus späterer Zeit sieht man das fleischige (M. longus capitis) Ende des Muskels hinter der Synch. spheno-occipitalis gelegen, aber selbst bei Neugeborenen kann man es noch dem hinteren Keilbeinkörper entsprechend finden. Untersucht man den Muskel am Erwachenen, so weicht seine Insertion von der, wie sie die Autoren angeben, nicht ab, der Muskel spitzt sich auch nicht mehr so zu wie bei Embryo, seine Insertion ist jetzt breiter geworden und gehört dem Os occipitale an -----".

"Auch der M. rectus capitis anticus minor inseriert beim Embryo und Neugeborenen weiter vorne als beim Erwachsenen, doch ist hier der Unterschied nicht so auffallend wie beim M rectus capitis anticus major".

Klaatsch ('00) makes a point of the fact that the origin of the short head of the biceps femoris in the fetus and newborn baby extends superiorly to the inferior end of the insertion of the glutaeus maximus, thus corresponding to the findings in certain of the primates. However, examination of fig. 17 shows that these conditions were not present in the baby studied in this investigation; and conversely, in the adult (Spaltholz) the origin of the short head of the biceps femoris extends proximably to very near the distal end of the insertion of the glutaeus maximus. Klaatsch continues in regard to the muscle:

"Die Insertion des Biceps femoris fand beim Menschen ursprüng-

lich eben so in der Unterschenkelfascie statt, wie bei anderen Primaten. Die Occupation des Capitulum fibulae als Knocheninsertion ist eine dem Menschen ausschliesslich zukommende Erwerbung. Dieselbe ist, wie ich finde, mit dem Schicksal des kurzen Bicepskopfes innig verknüpft, und da, wie mir scheint, dieser Punkt bisher unbeachtet geblieben ist, so will ich hier in Kürze darauf hinweisen. Jugendliche Stadien zeigen uns den Biceps (Fig. 5-6,- fetus and newborn) noch in den alten Zuständen der Insertion. Hier kann man noch nicht von einer eigentlichen Anheftung am Capitulum fibulae reden. Vielmehr ist hier offenbar dieselbe Beziehung zur Tibia, und zwar zum Condylus lateralis derselben ausgeprägt, wie bei den Formen, welche es nicht zu einer völligen Kniestreckung bringen. Die vereinigte Sehne der beiden Köpfe läuft in der Fortsetzung der Richtung des langen Kopfes zum Vorderteil der Tibia. Darunter aber erkennt man eine dreieckige bindegewebige Bildung, welche wie eine Art "Lacertus fibrosus" sich distal in die Unterschenkelfascie begiebt und gerade die Gegend des Capitulum fibulae einnimmt".

Hogge ('03) gives a detailed description of the anatomy of the "Muscles sphincter uro-génital et sphincter rectal" in the fetus and young child (newborn).

Forster ('03) draws attention to the fact that the M. semimembranosus acquires an additional attachment in the course of development to that which it had in fetal life.

"Erst bei dem menschlichen Neugeborenen treffen wir auf Beziehungen des Semimembranosus mit der Tibia, welche schliesslich zu der fertigen Ausbildung des gerade absteigenden, die Richtung des Muskels fortsetzenden Zipfels führt. Der Semimembranosus heftet sich zunächst an der hinteren Fläche dieses Knochens fest,

und es gelangt anderseits die mediale Sehne, eine sehr starke Knickung mit ihm bildend, zum Ansatze an dem Margo infraglenoidalis tibiae. Ursprünglich handelt es sich beim Fetus einfach um eine festere Fixirung dieser medialen Sehne an der hinteren Fläche der Tibia. Das Bindegewebe ist gleichsam noch nicht gerichtet. Man erkennt wohl schon den einen oder den anderen Zug, durch welchen die spätere Faserung angedeutet wird, doch in der Hauptsache hat die Verbindung der Endsehne der Semimembranosus mit der Hinterfläche des Knochens absolut nicht das Aussehen eines Sehnenzipfels, welcher, Muskelbündeln sich anschliessend, eine Insertion derselben an dem Skelett vermittelt".

Forster ('03) investigated the muscular system of an eight months (premature) Papua infant. He uses as material for comparison two European newborn babies, a full term child and a premature of the 7-7½ month. His notes are for the most part in regard to the regressive character of the muscles of the Papua in comparison to those of the white babies without any consistent attempt to describe the musculature of the latter, so his article throws little or no light on the normal myology of the white baby.

Gräfenberg ('04), working on the development of the pelvic musculature, dissected a number of fetuses of the twentieth to the twenty-third week. He states that his findings were negative since the muscles showed their relationships to be completed. Although the limits of the muscles were quite definite, their separation deeply was not complete. In the deeper layers the neighboring muscles were fused together and this fusion persisted longest in the case of the Mm. glutaei medius and minimus. Gräfenberg's statements at this point are not definite so it is

impossible to find out just how long the fusion persisted in the case of his material.

Weber and Collin('04) studied the muscle attachments on the ischial tuberosities of fifty fetuses (ages not given). Their conclusions are as follows:

"1. Il existe un type foetal caractérisé par l'insertion linéaire du biceps et du demi-tendineux et le clivage du tendon bicipital;" (1.)

"2. Un type adulte dérivé du précédent par l'extension en surface de l'insertion du biceps. A part quelques cas dont nous avons donné la description, tontes les disposition observées se ramènenent aisèment aux précédentes;"

"3. La continuité du biceps avec le grand ligament sacro sciatic chez le foetus et chez l'adulte doit être considérée comme la règle, étant donnée sa fréquence. Signification est bien connue."

Balli ('06) investigated the scapular attachment of the rhomboidei in 100 cadavers among which were 44 newborn babies. He distinguishes three main types of attachment. He makes no mention of any special peculiarities of insertion for the infants, but classifies them in with the adults. (Compare with the Mm. rhomboideus major and minor in this paper).

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1. In the newborn baby studied, I do not find the linear attachment of the biceps and the semitendinosus, but I do find a linear origin for the semimembranosus (q.v.).

Livini ('07), in an investigation on the Mm. scaleni, uses as incedental to his adult material 25 newborn children, but he does not call any attention to these specimens as being at all different from the adult. The babies are of interest to him only as they are confirmatory to the arguments in his paper.

Livini ('07), in a later paper on the M. serratus anterior assumes the same attitude as in his earlier paper towards the fifty late fetuses and newborn infants which he has as material for investigation.

Low ('07) mentions that in the fetus, as in the adult, the muscle of Treitz (when present) comes off the right crus of the diaphragm in all the cases he has studied. He says that in the fetus the bundle is easily dissected and that histologically it has in it both smooth and striated muscle fibers.

Steffens and Koerner ('10), investigating the muscular system of a newborn Papua child, think that Forster ('03) has drawn too sweeping conclusions in regard to the regressive nature of the musculature of the Papua. Their ~~results~~ conclusions are as follows:

"Eine Zusammenfassung ist wohl nicht nötig. Wenn Forster in Anbetracht der bekannten grossen Variabilität des Muskelsystems vor Verallgemeinerung der Befunde ~~a~~ l ~~x~~ einem neugeborenen Papua-Individuum warnt, so erfährt er durch unsere Untersuchung recht. Manches, was er fand und als regressiv, pithekoid deutete, fehlt hier - anderes ist vorhanden."

"Die Variabilität scheint so gross wie bei unserer eigenen Rasse, und die gesamte Strecke der Variationsbreite scheint nicht einmal abwärts, affen- oder überhaupt tierwärts gerückt gegenüber der des Europaers - wir brauchen noch viele Einzeluntersuchungen um das zu entscheiden."

Eckstein ('12), in some observations on the musculature of a negro-fœtus, comes to practically the same conclusions as do Steffens and Koerner ('10).

III. Material.

Four white babies were used in this investigation: No.2220, No.2339 and No.2289 of the cadaver series of the University of Minnesota, and an unnumbered newborn girl baby. The specimens were all fixed in formalin. No.2220 was a male of well-formed body, except the head which showed the results of considerable molding, being of the dolicocephalic type; his measurements were N.R. about 29 cm., C.R. 36.5 cm., Standing 55 cm., Circumference of Head 31.5 cm. No.2339 was a fairly well developed male with the following measurements: N.R. 26.5 cm., C.R. 35.5 cm., Standing 53.5 cm., Circumference of Head 34.5 cm. No.2289 was a well formed female: N.R. 29.5 cm., C.R. 37 cm., Standing 54 cm., Circumference of Head 34 cm. Not all the measurements were available on the unnumbered baby girl as the specimen had already been partially dissected. The data collected in this case were as follows: Standing 50.5 cm., Circumference of Head 36.7 cm., Circumference of Chest (just below the nipple line) 34.8 cm., Head-Umbilical Length 27.6 cm., Greater fontanelles 2.6 cm. All the casts except those for the arm, head and neck were made from No.2220. The cast of the arm was made from the unnumbered baby girl; those of the head and neck from No.2289. The muscle attachments were defined on No. 2339.

IV. Methods.

Two different points of attack were made use of in investigating this problem. First, casts were made from careful dissections of the musculature of the trunk and extremities, the dissections being chosen with care to portray as much of the myology as possible. Second, the bony attachments of the muscles were worked out.

CASTING: In making the cast, naturally the first requisite was a clean dissection of the muscles to be modelled. The dissected parts were covered by a thin layer of vaseline to prevent the plaster of Paris from sticking to the tissues. Preparatory to the actual construction of the cast a supporting base was made by pouring a thick layer of the plaster suspension on a flat surface, spreading it over an area considerably larger than the size of the part being modelled, and allowing it partially to set. While the base was hardening a thin solution of the plaster was poured on the most level surface of the dissection (the back, in the case of the trunk models) and this surface was immediately laid upon the fairly hard base. The two layers of plaster fused together, of course, so that the baby was now lying on a strong slab of plaster which had on it an accurate impression of the back musculature, and which extended out around the edges 5-6 cm. to support the lateral parts of the mold as they were built up. Before the base had hardened so as to be practically unworkable, it was necessary to trim off any large irregularities which, if left on, would hinder the separation of the parts of the mold during the dismantling process. The projecting edges of the base on which the next portions were to rest were then painted with a solution, first, of alcoholic shellac and after this had dried, with one of sandrac in 95% alcohol to keep the subsequent parts from fusing with the base and to prevent the

extraction of water from them by the base before they x had set. The next step was the building up of the lateral parts of the mold by covering the sides of the dissection with a layer of rather thick plaster by the use of a spatula. The trimming and painting done on the base had to be repeated in this case also. The ventral sections were then made in a similar way to the construction of the lateral ones. The sections of plaster were made from two to three cm. in thickness to give the necessary strength for manipulation. In reaching up into small recesses, like the axilla, where it would be very difficult to handle the hard plaster (especially in removing the mold from the wax model) it was found convenient to build a wall of plaster around the recess so as to leave it in the form of a small reservoir. Before the ventral parts of the mold were made, a very thick solution of warm gelatin was poured into the pocket so as to fill it completely. Since the gelatin was fairly elastic when cold, the plug was readily worked out of the pit without losing the true shape of the region. On account of the ease with which gelatin might be torn, and especially because its low melting point, it was found advisable to avoid its use wherever possible.

After the plaster had set, and the gelatin hardened, the mold was removed from the dissection by pieces. It was this step that showed the serviceability of the shellac and sand rac, for the parts of the case separated along the lines of painting and the brown shellac gave a much needed guide to the surfaces of any two adjacent sections. In removing the mold the sections were taken off in the reverse order to that in which they had been made in building the cast. Here also it became evident why the cast had been built up in its many sections; no section of hardened plaster could be removed successfully if it gripped around the dissection more than half way,

as if it dipped into two or more deep recesses whose sides were not parallel so that the hardened plaster was locked in, "dove-tailed". As the parts of the cast were removed they were kept in proper order so that they could easily be rebuilt into the hollow mold of the dissection from which they had just been taken. This mold was held together by heavy rubber bands and all the openings from its interior were sealed with warm pliable wax, excepting that through which the wax for the model was to be poured.

More wax than was needed to fill up the cast was heated to melting, allowed to cool until it was about to solidify, and was then poured into the mold (the precaution of cooling the wax was especially necessary where gelatin had been used as a part of the cast, for even after allowing the wax to cool until partly solid there was some softening of the gelatin). A surplus of wax was prepared for there was usually some leakage from the mold. The wax was left untouched ten to twelve hours to assure complete solidification, and the plaster of Paris was removed from it in the same way as from the dissection. Much additional care had to be exercised in this process on account of the brittle nature of the wax. The necessity for avoiding any gripping or wedge-shaped processes in making the cast was especially emphasized at this point, for more difficulty would have been experienced in removing such parts of the cast from the hard wax than from the fairly pliable dissection.

The next step in the process was to smooth up the rough model. Residual pieces of plaster were carefully cleaned off. Bumps and hollows which had arisen from faulty technique in casting were removed by means of a hot wax-spatula; a pair of dividers checked the model against the actual dissection so as to give a reasonably high grade of accuracy. The surfaces were prepared for paint by

first smoothing them with the spatula and then rubbing them down with a cloth dipped in xylol. The paints used were ordinary oil pigments suspended in xylol. The very fine lines on the models showing the directions of the muscle fasciculi were drawn by means of a ruling pen and a paint of thin consistency (see fig. 20-26).

MUSCLE ATTACHMENTS- The muscle attachments were defined according to the 'pyrographical method' of Sclavunos ('07) somewhat modified. Sclavunos dissected out the origin or insertion and cut around it so as to remove the surrounding periosteum. After drying the bone with a cloth he burned into it with a pyrographical needle so as to outline the attachment which he then lifted off by means of a cartilage knife. The modification of the Sclavunos method used in this investigation was the substitution of the less cumbersome electric cautery for the old-fashioned pyrographical outfit which required constant attention in order to be kept hot.

V. Topography of the Musculature of the Baby.

Meeh ('95) has made a number of very good measurements of the body at different ages. A portion of one of his tables, including measurements on two newborn babies and two adults, has been made use of in this paper in order to give a general idea of differences in muscle topography between the newborn musculature and that of the adult. In order to obtain a fair basis of comparison for this paper, Meeh's figures have been put into percentages of the total length of the individual measured; the total length is therefore represented as 100.

If the table be consulted (pp. 18 and 19). it will be seen that the circumference of the chest and abdomen, the greatest diameter of the chest in both the sternovertebral and the costal (side to side) directions are significantly greater in the newborn than in the adult. Comparison, then, with figures 20, 21, and 22, indicates in a general way that in baby No 2220 these same measurements would be relatively greater than in the adult. Also, it is noticeable that the muscles of the back are much less concerned in these increased proportions than are thos of the ventral abdominal and thoracic walls. The pelvis is certainly smaller relatively than in the adult, but there seems to be little effect on the appearances of the musculature of this region for the general conformation is much like that of the adult. Both the upper and lower extremities are relatively shorter in the baby than in the adult according to Meeh. In the upper extremity the arm and fore-arm are both relatively short; the hand, variable. At the same time the circumference of the arm is greater than in the adult. Possibly that of the fore-arm is also greater. These circumferential

differences apparently depend on the fact that the arm and fore-arm muscles are larger, relative to the length of the extremity, than in the adult, (see fig. 24). The circumference of the thigh is not very significant according to Meeh. That of the leg is given as smaller in the newborn than in the adult. Meeh's figures show that all the measurements he made on the head are larger in the baby than in the adult. Relative to the musculature, it is very noticeable that the muscles of the back of the neck, at least, are much spread out laterally in order that they may conform to the large skull (see the table,- 'Entfernung zwischen beiden Warzenfortsätzen', and especially fig. 25 - c). The small size of the temporal muscle is very marked.

(1) Messung von homologen Alter.	(a) Neugeboren.	(b) 22Jahr 2/3 Mon.
Gewicht dem ganzen Körpers in g.	3956	54700
1. Gesammtlänge	55.0	162.0
2. Peripherie um Stirn und Hinterhaupt	37.0	56.0
3. Peripherie um Kinn und Scheitel	40.5	63.0
4. Entfernung von Hinterhaupt zur Stirn	13.5	18.5
5. Entfernung von Hinterhaupt zum Kinn	14.5	24.0
6. Entfernung zwischen beiden Schläfen	7.5	13.0
7. Entfernung zwischen beiden Warzenfortsätzen	8.5	13.5
8. Entfernung beider Hüftkämme	9.2	27.5
9. Entfernung beider spin. ant. sup.	8.0	25.0
10. Conjugata externa	5.0	17.5
11. Entfernung beider Trochanter. maj.	(9)	31.0
12. Beckenperipherie	30.0	78.0
13. Länge vom Acromion bis zur Spitze des Mittelfingers	23.0	75.5
14. Länge des Oberarms	9.5	30.5
15. Länge des Unterarms	7.0	25.5
16. Länge der Hand	6.5	19.5
17. Peripherie um das Handgelenk	7.5	15.5
18. Grösste Peripherie um den Unterarm	10.7	26.0
19. Grösste Peripherie um den Oberarm	11.5	24.5
20. Länge von der Spitze des Trochant. major bis zur Fusssohle	23.0	86.0
21. Länge des Oberschenkels	11.0	42.5
22. Länge des Unterschenkels	10.0	37.5
23. LLänge des Fusses vom Fussgelenk bis zur Fusssohle	3.0	6.0
24. Länge des Fusses von der Ferse bis zur Spitze der grossen Zehe	9.0	27.5
25. Peripherie des Oberschenkels	17.0	44.5
26. Peripherie des Unterschenkels	10.7	33.5
27. Peripherie des Fusses um Ferse und Fussrücken	11.0	31.0
28. Peripherie des Fussgelenkes	9.0	24.0
29. Grösster Sternovertebraldurchmesser	8.0	17.5
30. Grösster Costaldurchmesser	11.2	27.0
31. Brustperipherie	33.0	78.0
32. Bauchperipherie	27.5	73.5

(1) The first four columns of measurements are copied from Meeh (95). The last four columns represent the same measurements calculated in percentages of the total length which, of course, is taken as 100. The last four columns were calculated by the writer.

Linien (in Centimeter).

	(c) Neugebor.	(d) 22 Jahr 2½ Mon.	In % of total length of a	% of total length of "b".	% of total length of "c"	% of total length of "d"
	2840	60230				
1.	50.0	156.0	100.0	100.0	100.0	100.0
2.	32.5	52.5	67.2	34.2	65.0	33.6
3.	37.5	63.5	73.6	38.8	75.0	40.7
4.	12.0	17.0	24.5	11.4	24.0	10.9
5.	13.0	23.0	26.4	14.8	26.0	14.7
6.	7.0	10.5	13.6	8.0	14.0	6.7
7.	9.0	13.5	15.4	8.3	18.0	8.8
8.	8.5	28.5	16.7	16.9	17.0	18.2
9.	6.8	25.0	14.5	15.4	13.6	16.0
10.	5.0	22.0	9.0	10.8	10.0	14.1
11.	8.5	31.0	16.3	19.1	17.0	19.8
12.	25.0	91.0	54.5	48.1	50.0	58.3
13.	20.0	66.5	41.8	46.6	40.0	42.6
14.	8.0	28.5	17.4	18.8	16.0	18.2
15.	5.5	22.0	12.7	15.7	11.0	14.1
16.	6.5	16.0	11.8	12.0	13.0	10.2
17.	5.5	17.0	13.6	9.5	11.0	10.9
18.	8.0	25.5	19.4	16.0	16.0	16.3
19.	10.0	28.0	20.9	15.1	20.0	17.9
20.	21.5	82.0	41.8	53.1	43.0	52.5
21.	10.5	40.0	20.0	26.2	21.0	25.6
22.	8.0	35.0	18.1	23.1	16.0	22.4
23.	3.0	7.0	5.2	3.7	6.0	4.4
24.	8.0	24.5	16.3	16.9	16.0	15.7
25.	15.0	57.0	30.9	27.4	30.0	36.5
26.	10.5	36.5	19.4	20.7	21.0	23.4
27.	9.5	31.0	20.0	19.1	19.0	19.8
28.	8.0	24.5	16.3	14.8	16.0	15.7
29.	7.5	18.0	14.5	10.8	15.0	11.5
30.	9.2	27.0	20.3	16.6	18.4	17.3
31.	30.0	88.0	60.0	48.1	60.0	56.4
32.	25.0	75.5	50.0	45.3	50.0	48.5

VI Attachments of the Individual Muscles.

In working out the details of attachment of each of the muscles of the newborn it has appeared that there are three general types of bony origin or insertion: first, there is the ordinary tendinous attachment as in the adult; second there is the fleshy attachment which is also found in the adult; and third, there is a very weak attachment which requires a few words of explanation.

An understanding of the appearance of the attachments of the muscles falling under type three can best be given by describing the appearances during the dissection of the muscle. If the muscle is cut across between its origin and insertion and then lifted up so that the dissection leads back towards this peculiar attachment it will be found that, instead of arriving at any set line where one may define the beginning of the attachment, little or no attachment appears. Possibly a few of the muscle fibers will be seen to have a slight connection with the periosteum by means of very delicate connective tissue strands. For the most part, however, the muscle fibers are united with the bone merely by a bit of loose, areolar-appearing connective tissue whose fibers very apparently do not run in the same direction as the muscle fibers. These conditions hold along the whole surface of the bone to which the muscle is applied. We are dealing then with an approximation rather than with an attachment of the muscle to the bone. This approximation occurs over an area which corresponds fairly closely to the adult attachment of the muscle on the bone. It is to be noted that the muscle is strongly adherent to the intermuscular septa and interosseous ligaments related to it and that these septa and ligaments are very firmly connected to the bone, so that

there is a strong indirect attachment of the muscle to the bone. Of course, classifying muscle attachments in three or any number of types is at best very arbitrary and artificial, for there are all gradations between any two classes. No apology is forthcoming for this method of presentation, however, for it is to be plainly understood that it is solely for purposes of convenience. Statements will be made as to individual deviations from any type that a muscle may fall under (see under the individual muscles).

In general it appears that this third type of attachment occurs in certain of the muscles of the extremities especially, and particularly those which have their muscle fibers running to the bone at a very acute angle.

The muscles are here considered in the order of their listing as given in Barker's Anatomical Terminology under the heading "Myologia". Muscles which have not been worked out have been left out of the series.

In regard to the comparisons of the newborn attachments with the adult, Spaltehols's Atlas has been used as the basis for the normal adult myology. Where other works have been consulted, especial mention is made under the individual muscles.

MUSCULI DORSI.

M. trapezius. Origin: cranial portion, not completed enough for a detailed report. The rest of the origin extends downwards attaching to the ligamentum nuchae, spinous processes of the seventh cervical to the eleventh thoracic vertebrae and the interspinous ligaments. Cranial attachment mainly fleshy, the rest tendinous. Insertion: lateral one third of the superior surface of the posterior border of the clavicle, superior margin of the acromion and of the spine of the

scapula. Fleshy except towards the medial end of the insertion. Remarks: corresponds closely to the description of the origin and insertion as given by Spalteholz.

M. latissimus dorsi. Origin: From the iliac crest in about the same position as in the adult; from the lumbodorsal fascia downwards from the seventh thoracic spine, the angles of the four lower ribs, the inferior angle of the scapula. The origin is all tendinous. Insertion: tendinous, completely fused with the teres major towards the humerus. The position is the same as usually described for the adult.

M. rhomboideus major. Origin: extends from the spinous process of the seventh to that of the fifth thoracic vertebra and from the corresponding interspinous ligaments. Tendinous. Insertion: only the inferior fibers are attached to the dorsal side of the vertebral border of the scapula. Most of the attachment is on the costal side of the border, thus displacing the serratus anterior more laterally (see figs. 3 and 4). The insertion is fleshy.

M. rhomboideus minor. Origin: tendinous from the ligamentum nuchae extending 1 cm. superiorly from the spinous process of the seventh cervical vertebra. Insertion: only the superior fibers are attached to the dorsal side of the vertebral border of the scapula. The remaining more inferior fibers are ventral, thus displacing the superior portion of the insertion of the serratus anterior more laterally on the scapula (see figs. 3 and 4). The insertion is fleshy. Remarks: A dissection of another newborn made as a check on these findings corroborates them for both the major and minor rhomboidei. It would be well to state at this point that the exact location of the insertion of these muscles is not very evident unless one actually marks out their attachment; a simple dissection does not demonstrate the above points satisfactorily. Balli ('06)

working on the insertion of the 'M. rhomboideus' in 44 newborn children and 66 adults, makes no mention of finding any such attachment as is above described. It is of interest that the position of the insertion of the M. rhomboideus in the cat (which probably represents the human rhomboidei) corresponds closely to that reported in this paper. Reichard and Jennings ('01) make the following statement in this regard:

"Insertion by a short tendon (1 millimeter long) into the vertebral border of the scapula, the line of insertion passing gradually from the inner (Fig.78,e) to the outer (Fig.76,i)surface".

M. levator scapulae. Origin: not worked out as yet. Insertion: since the medial angle of the scapula is much reduced, practically absent, in the newborn studied, the insertion of the levator scapulae appeared to be on the superior border of the scapula. Both dorsal and ventral sides of the border of the scapula are included in the attachment. Fleshy.

M. sacrospinalis. Origin: corresponded closely to the origin as given by Spaltehols,- "in der Tiefe fleischig, sonst mit langen Sehnen von crista iliaca, ligg. sacroiliaca posteriora, crista sacralis media und proc. spinosi der Lendenwirbel". Insertion: not worked out as yet. Remarks: It is scarcely accurate to speak of part of the muscle arising from the crista sacralis media inasmuch as the sacral crest of the newborn is undeveloped. The sacrospinalis arises really from the region of the future crista iliaca.

M. multifidus. Origin: from the dorsum of the sacrum, the posterior sacroiliac ligaments, and the tuberosity of the ilium. The rest of the origin and the insertion have not been worked out as

yet. These attachments correspond, so far as they have been investigated, with the description of the muscle for the adult.

MUSCULI COLLI.

M. sternocleidomastoideus. Origin: clavicular head, fleshy, from the upper, medial portion of the clavicle. Sternal head, tendinous, from the anterior surface of the manubrium sterni. Corresponds to the adult. Insertion: not worked out as yet.

M. sternohyoideus. Origin: the clavicular portion, from the dorsal surface on the medial end of the clavicle. The position of this part of the muscle corresponds to the adult attachment, but the area of origin is very markedly reduced. The rest of the muscle has not been worked out.

M. omohyoideus. Origin (i.e., scapular attachment): from the portion of the superior border of the scapula medial to the incisura scapulae. The muscle does not arise from the ligamentum transversum superius scapulae (which is ossified in this specimen). Insertion: not worked out.

MUSCULI THORACIS.

M. pectoralis major. Origin: the areas of attachment are approximately the same as in the adult. The fibers are most strongly attached where the anterior intercostal membranes are inserted to the upper and lower borders of the costal cartilages. Most of the origin is fleshy, but the attachment on the fifth rib is of the peculiar 'type III', which has been described in the explanation at the beginning of this section. Insertion: tendinous, on the crista tuberculi majoris humeri, corresponding in its peculiarities to the adult muscle.

M. pectoralis minor. Origin: Incompletely worked out as yet. Insertion: tip of the coracoid process of the scapula. Fleshy. Corresponds to the adult attachment.

M. subclavius. Origin: not worked out as yet. Insertion: fleshy, on the inferior surface of the clavicle, corresponding to the adult attachment.

M. serratus anterior. Origin: not worked out as yet. Insertion: fleshy; more laterally placed on the scapula than usually described for the adult, because of the position of the insertion of the rhomboidei. Both the extreme upper and lower ends of the insertion extend around the border of the scapula to attach to the dorsal surface for a short extent (see figs. 3 and 4).

MUSCULI ABDOMINIS.

M. rectus abdominis. Origin: not worked out as yet. Insertion: tendinous, on the superior ramus of the pubis and the anterior surface of the symphysis, thus corresponding to the adult. The insertion covers a relatively large area.

M. pyramidalis. Origin: fleshy, anterior and lateral to the insertion of the rectus abdominis on the pubis. Insertion: into the linea alba. The muscle is entirely similar to the adult muscle.

M. obliquus externus abdominis. Origin: osseous portion not worked out as yet. (See after M. transversus abdominis). Insertion: the iliac attachment corresponds in position and extent to the adult, thus inserting into approximately the anterior one-half of the lateral lip of the iliac crest. This portion of the muscle is fleshy.

M. obliquus internus abdominis, Origin: the anterior half of the intermediate portion of the iliac crest, lumbodorsal fascia,

and fused with the transversus abdominis from the lateral part of the inguinal ligament, thus corresponding to the adult. Insertion: osseous insertion not worked out as yet (see after M. transversus abdominis).

M. transversus abdominis. Origin: the costal attachments not worked out as yet. From the lumbodorsal fascia, the anterior half of the medial lip of the iliac crest, and fused with the internal oblique from the lateral half of the inguinal ligament. The origin corresponds closely to the adult. Insertion: see the following. Remarks: the fascial relationships of the Mm. obliquus externus and internus abdominis and the transversus abdominis correspond to the descriptions as usually given for the adult.

MUSCULI COCCYGEI.

M. coccygeus. The muscle is relatively large, and the muscle fibers are inseparably mixed with the fibers of the sacrospinous ligament. Origin: spina ischiadica over an area somewhat larger than shown for the adult. The large size of the area is probably due to the fact that the muscle could not be dissected away from the ligament so that both had to be marked out together. Insertion: lateral border of the coccyx and of the lower sacral vertebrae.

Mm. sacrococcygeus anterior and posterior. Not found in the specimen dissected. Blum ('94) states that these muscles are probably occasionally present in the newborn as in the adult.

MUSCULI EXTREMITATIS SUPERIORIS.

M. deltoideus. Origin: lateral third of the anterior border of the clavicle; tip and lateral border of the acromion; inferior lip of the spina of the scapula. Fleshy. Insertion: lateral surface of the shaft of the humerus at the junction of the middle and upper

thirds of the bone. The deltoid tuberosity was not present as the distinct ridge which one sees in the adult. The muscle attaches more proximally than is pictured by Spalteholz. Fleshy.

M. supraspinatus. Origin: fleshy, from the supraspinous fossa of the scapula as in the adult. Insertion: a short tendon on the major tubercle of the humerus in relatively the same position as in the adult. See remarks under M. teres minor.

M. infraspinatus. Origin: fleshy, from the infraspinous fossa of the scapula, practically the same as in the adult. Insertion: tendinous, on the major tubercle of the humerus in relatively the same position as in the adult. See remarks under M. teres minor.

M. teres minor. Origin: fleshy, from the lateral border of the scapula on the dorsal surface, and extending inferiorly between the attachments of the teres major and the infraspinatus. Insertion: major tubercle of the humerus in relatively the same position as in the adult. Tendinous. Remarks: the impressions for the M. supraspinatus, infraspinatus, and teres minor on the greater tubercle of the humerus are not present but the attachments are in the same relative positions as is usually pictured for the adult.

M. teres major. Origin: fleshy, from the lateral portion of the dorsal surface of the inferior angle and lower one-third of the lateral border of the scapula. Insertion: tendinous and fused with the latissimus dorsi; otherwise the muscle corresponds closely to the description given for adult.

M. subscapularis. Origin: fleshy from the costal surface of the scapula, and at one point extending around the lateral border of the scapula to attach for a slight extent to the dorsal surface. Insertion: tendinous, on the minor tubercle of the humerus. The muscle is thus essentially the same as in the adult.

M. biceps brachii. Origin: long head tendinous from a small portion of the scapula immediately above the glenoid fossa, fused in with the labrum glenoidale. The short head is fused with the coracobrachialis and the two muscles arise on a rather extensive surface from the inferior side of the tip of the coracoid process (see figs.3, 4 and 5). Insertion: tendinous, into the lacertus fibrosus, and on the relatively indistinct radial tuberosity. The muscle was much the same as in the adult.

M. coracobrachialis. Origin: tendinous. See M. biceps brachii, short head. Insertion: fleshy, on the medial border of the shaft of the humerus just proximal to the middle of the length of the bone. Approximately the same as in the adult.

M. brachialis. Origin: extends farther proximally and distally on the anterior surface of the shaft of the humerus than is usually pictured for the adult. The origin is of the third type as described in the explanatory paragraph at the beginning of this section of the paper. Insertion: more proximally situated on the coronoid process than is shown in Spaltehols's Atlas. Fleshy.

M. triceps brachii. Origin: the long head arises from the scapula, the other two from the humerus in the same manner as is described for the adult. The origin is all fleshy. Insertion: olecranon on a more extensive area than in the adult. Tendinous. The triceps and the anconaeus are dissected away from one another only with difficulty.

M. anconaeus. Origin: lateral epicondyle of the humerus. Fleshy. Corresponds to the adult. Insertion: dorsal surface of the ulna, over an area somewhat shorter and broader than, but in the same position as in the adult. Fleshy.

M. pronator teres. Origin: caput humerale from the medial epicondyle of the humerus, in about the same position as in the adult. Fleshy. Caput ulnare, split into two portions between which runs a vein which more distally accompanies the ulnar nerve. Tendinous. Insertion: on the volar and radial surfaces of the radius, curving around the bone the same as in the adult. Tendinous.

M. flexor carpi radialis. Origin: fused with the surrounding muscles from the medial epicondyle of the humerus distal to the origin of the pronator teres. Same as the adult. Tendinous. Insertion: not worked out as yet.

M. palmaris longus. Origin: medial epicondyle of the humerus distal to the origin of the pronator teres and fused with the surrounding muscles. Tendinous. Insertion: aponeurosis palmaris. Tendinous. The muscle-~~was~~[is] essentially the same as in the adult.

M. flexor carpi ulnaris. Origin: caput humerale, from the medial epicondyle of the humerus fused in with the other flexors of the region. Tendinous. Caput ulnare from the medial and dorsal portion of the olecranon and the dorsal margin of the ulna through the medium of the fascia covering the muscle. Insertion: not worked out as yet.

M. flexor digitorum sublimis. Origin: caput humerale, from the medial epicondyle of the humerus, fused in with the rest of the flexors; also from the volar surface of the shaft of the ulna just distal to the coronoid process. Caput radiale, from the volar surface of the radius. Tendinous. Insertion: not worked out as yet. The origin is essentially the same as in the adult.

M. flexor digitorum profundus. Origin: volar and ulnar surfaces of the ulna corresponding to the origin in the adult. Insertion: not worked out as yet.

M. flexor pollicis longus. Origin: volar surface of the radius. The thin head from the medial epicondyle of the humerus is present, running along with the flexor digitorum sublimis. Essentially the same as in the adult. Insertion: not worked out as yet.

M. pronator quadratus. Origin: from the volar surface on the distal end of the ulna, but covering a larger area than is usual in the adult. The origin is intermediate between the ordinary fleshy attachment and 'type III' described above. Insertion: volar surface on the distal end of the radius. Fleshy.

M. brachioradialis. Origin: tendinous, from the proximal portion of the lateral margin of the humerus, in the same position as in the adult, but from a less extensive area. Insertion: tendinous, laterally on the distal end of the ulna, corresponding to the adult.

M. extensor carpi radialis longus. Origin: tendinous, just distal to the origin of the brachioradialis on the humerus, as in the adult. Insertion: not worked out as yet.

M. extensor carpi radialis brevis. Origin: tendinous, from the lateral epicondyle of the humerus, fused in with the other extensors as in the adult. Insertion: not worked out as yet.

M. extensor digitorum communis. Origin: tendinous, from the lateral epicondyle of the humerus, fused with the neighboring extensors. Same as the adult. Insertion: not worked out as yet.

M. extensor digiti quinti proprius. Origin: tendinous, from the lateral epicondyle of the humerus, fused in with the other extensors. As in the adult. Insertion: not worked out as yet.

M. extensor carpi ulnaris. Origin: from the lateral epicondyle of the humerus, fused with the neighboring muscles, from the dorsal surface of the ulna, lateral to the insertion of the anconaeus on a considerably less extensive area than in the adult, and in addition, from a small area on the proximal end of the shaft of the radius. Tendinous. Insertion: not worked out as yet.

M. supinator. Origin: from the lateral epicondyle of the humerus, and the medial portion of the upper end of the ulna (not in such a position as to allow of being shown in the figures, but from the same area relatively as in the adult). Insertion: partially surrounding the proximal end of the radius, on its volar, radial and dorsal surfaces.

M. abductor pollicis longus. Origin: dorsal surface of the radius and ulna, less extensive and more proximal on the ulna than in the adult, and in the same position on the radius as in the adult. Insertion: not worked out as yet.

M. extensor pollicis brevis. Origin: dorsal surface from the proximal portion of the distal one-fourth of the radius. Same as in the adult. Insertion: not worked out as yet.

M. extensor pollicis longus. Origin: Dorsal surface of the ulna from the whole of the middle third of the bone. Insertion: not worked out as yet.

M. extensor indicis proprius. Origin: dorsal surface of the ulna in the same relative position as in the adult but covering a longer and broader area. Insertion: not worked out as yet.

M. palmaris brevis. The muscle ~~was~~ is present as a few fibers running from the palmar aponeurosis ~~laterally~~ medially into the integument of the hypothenar eminence.

MUSCULI EXTREMITATIS INFERIORIS.

M. iliopsoas.

M. iliacus. Origin: from the iliac fossa and both the anterior superior and inferior iliac spines, covering a relatively larger area than in the adult. Fleshy. Insertion: Mainly tendinous, fused with the psoas major on the lesser trochanter of the femur, as in the adult.

M. psoas major. Origin: not worked out as yet. Insertion: Tendinous, fused with the iliacus on the lesser trochanter of the femur. Same as in the adult.

M. psoas minor. Origin: not worked out as yet. Insertion: Tendinous into the fascia iliacus, as in the adult.

M. glutaeus maximus. Origin: from the lateral surface of the ilium posterior to the posterior glutæal line, the postero-lateral surfaces of the upper end of the coccyx and the lower portion of the sacrum, the posterior sacroiliac ligaments, and the ligamentum sacrotuberosum. Fleshy. Insertion: tendinous into the tractus iliotibialis, lateral surface of the greater trochanter of the femur, shaft of the femur in the same position as the glutæal tuberosity of the adult (the glutæal tuberosity is not in evidence at this time, the bone presenting a smooth surface, slightly raised). The whole muscle corresponds closely to that of the adult.

M. glutaeus medius. Origin: lateral surface of the ilium between the anterior and posterior glutæal lines. Fleshy. Insertion: tendinous, superior and lateral surfaces of the greater trochanter of the femur. Same as in the adult.

M. glutaeus minimus. Origin: lateral surface of the ilium between the inferior and anterior glutæal lines. Fleshy. Insertio tendinous, on the anterior surface of the greater trochanter of t

femur. The muscle is essentially the same as in the adult.

M. tensor fasciae latae. Origin: fleshy, from the lateral portion of the anterior superior iliac spine. Insertion: tractus iliotibialis. Same as the adult.

M. piriformis. Origin: lateral portion of the anterior surface of the middle three pieces of the sacrum extending somewhat more medially than usually shown for the adult. Fleshy. Insertion: tendinous, tip of the greater trochanter of the femur. Same as in the adult.

M. obturator internus. Origin: from the obturator membrane and the os coxae surrounding the upper half of the obturator foramen on a continuous area running dorsally to the greater sciatic notch, rather than on two areas, the one in front of, the other behind the obturator foramen, as pictured in Spaltehols's Atlas. Fleshy. Insertion: tendinous, fused with the gemelli, to the trochanteric fossa of the femur. Same as in the adult.

M. gemellus superior. Origin: fleshy, inseparably fused with the gemellus inferior, inferiorly and laterally on the ischial spine extending inferiorly and laterally in a semicircle around the lesser sciatic notch to the ischial tuberosity. The origin of the two muscles is somewhat more extensive than is usually shown for the adult. Insertion: tendinous, fused with the anterior superior edge of the tendon of the obturator internus to the trochanteric fossa of the femur.

M. gemellus inferior. Origin: see gemellus superior. Insertion: tendinous, fused with the posterior inferior edge of the tendon of the obturator internus to the trochanteric fossa of the femur.

M. quadratus femoris. Origin: fleshy, from the lateral surface of the ischial tuberosity, the same as in the adult. Insertion: tendinous, on the intertrochanteric crest of the femur, covering a relatively larger area than in the adult.

M. sartorius. Origin: fleshy, from the anterior superior spine of the ilium, the same as in the adult. Insertion: in addition to the ordinary tendinous attachment to the medial side of the tuberosity of the tibia, there is continuous with it a strong fibrous sheet of insertion, running inferiorly onto the shaft of the tibia.

M. quadriceps femoris. Origin: see the following three muscles. Insertion: the attachment of the patellar ligament to the tuberosity of the tibia is the same as in the adult.

M. rectus femoris. Origin: both heads are tendinous. The findings here corroborate those of Williams ('79), in that the acetabular head is relatively very strong and is the direct continuation of the muscle while the attachment to the anterior inferior iliac spine is considerably reduced and weak, and appears to be more a side attachment of the muscle (see fig.14). Insertion: tendinous, into the common tendon of the other members of the quadriceps on the superior portion of the patella.

M. vastus lateralis. Origin: anterior and lateral surfaces of the greater trochanter of the femur and lateral portion of posterior border of the shaft of the femur (which corresponds to the future linea aspera), but completely fused with the superior and lateral portion of the vastus intermedius. Mainly fleshy, but superiorly type III. Insertion: common tendon of the quadriceps. Tendinous.

M. vastus intermedius. Origin: anterior surface of the shaft of the femur as in the adult, but fused superiorly with the

vastus medialis and laterally and superiorly with the vastus lateralis. Fleshy. Insertion: common tendon of the quadriceps.

M. vastus medialis. Origin: fused superiorly with the vastus intermedius, and extending inferiorly on the area of what will later be the lateral lip of the linea aspera. Fleshy. Insertion: common tendon. Same as in the adult.

M. articularis genu. Origin: two areas, one large, the other small on the anterior surface of the shaft of the femur distal to the attachment of the vastus intermedius. Fleshy. Insertion: superior part of the capsule of the knee joint. The muscle is especially well developed.

M. pectineus. Origin: superior ramus of the pubis on an area somewhat larger than in the adult. Insertion: lesser trochanter of the femur, and on a line extending 1 cm. inferiorly from the lesser trochanter. Approximately the same as in the adult.

M. adductor longus. Origin: from the anterior surface of the superior ramus of the pubis. The origin is split into two parts; the medial is larger and tendinous, the lateral smaller and fleshy (see fig.10). The two heads joined inseparably at about 1.8 cm. from the pubis. Insertion: mainly tendinous, but somewhat fleshy on the femur in the position of the future linea aspera, medial to the vastus medialis.

M. gracilis. Origin: anteriorly and medially on the inferior ramus and body of the pubis. Tendinous. Insertion: a small area on the tuberosity of the tibia, just behind the insertion of the sartorius. Tendinous. Same as in the adult.

M. adductor brevis. Origin: anteriorly on the pubis, just lateral to the origin of the gracilis. Mainly fleshy but somewhat tendinous. Corresponds to the adult. Insertion: superior portion of the future linea aspera, just lateral to the insertion of the pectineus. Tendinous. Does not extend so far distally as in the adult.

M. adductor magnus. Origin: ischial tuberosity and the anterior aspect of the inferior ramus of the pubis. Fleshy. Insertion: fleshy, shaft of the femur on the distal two-thirds of what will later be the linea aspera. Also tendinous on the medial epicondyle, and extending superiorly for about 1 cm. towards the more superior attachment. Practically the same as in the adult.

M. adductor minimus. Origin: much reduced and just lateral and inferior to the origin of the adductor longus on the pubis (see fig.10). Fleshy. Insertion: tendinous to the proximal portion of the future linea aspera. The muscle is relatively small. The origin is situated much more superiorly than is usually shown for the adult.

M. obturator externus. Origin: ~~fmt~~ fleshy from the lateral side of the obturator membrane and the medial two-thirds of the os coxae forming the boundary of the obturator foramen. Insertion: fleshy to the trochanteric fossa of the femur. The origin is somewhat more extensive than is pictured by Spaltehols. Otherwise the muscle ~~was~~ much the same as in the adult.

M. biceps femoris. Origin: the long head is tendinous and arises from the postero-lateral aspect of the ischial tuberosity. The short head is fleshy and arises from the distal third of the future linea aspera. Insertion: lateral aspect of the head of the

fibula. Tendinous. The muscle corresponds closely to the adult.

M. semitendinosus. Origin: mainly tendinous but containing a few fleshy fibers. The attachment is on the ischial tuberosity inferior and medial to the origin of the biceps femoris. Insertion: tendinous to the tuberosity of the tibia posterior to the insertion of the sartorius, and distal to that of the gracilis. The muscle corresponds closely to that of the adult.

M. semimembranosus. Origin: lateral surface of the ischial tuberosity between the origin of the quadratus femoris and the biceps femoris. Tendinous. The origin is considerably reduced (see fig.14). Insertion: posterior surface of the medial condyle of the tibia. Tendinous. Same as in the adult.

M. tibialis anterior. Origin: proximal one-half of the lateral surface of the tibia, as in the adult; but in addition a small tendinous attachment to the upper end of the fibula (see fig.18). The attachment to the tibia is of the third type explained in the introductory paragraphs at the beginning of this section. Insertion: not worked out as yet.

M. extensor digitorum longus. Origin: lateral condyle of the tibia, head and shaft of the fibula along the anterior portion of the medial surface of the bone. Mainly fleshy but tendinous proximally. The origin is the same as in the adult. Insertion: not worked out as yet.

M. peronaeus tertius. Not present.

M. extensor hallucis longus. Origin: medial surface of the shaft of the fibula along the attachment of the interosseous membrane as well as from the membrane itself. Fleshy. Same as in the adult. Insertion: not worked out as yet.

M. peronaeus longus. Origin: fleshy, from the head and lateral surface of the upper third of the shaft of the fibula, and to a very slight extent superiorly from the lateral condyle of the tibia (see fig.18). Insertion: not worked out as yet.

M. peronaeus brevis. Origin: fleshy, from the distal two-thirds of the shaft of the fibula, extending distally to the posterior aspect of lateral malleolus. The origin extends much farther distally than is usual for the adult. Insertion: not worked out as yet.

M. triceps surae.

M. gastrocnemius. Origin: both heads are mixed tendinous and fleshy. The medial head arises from the popliteal plane just proximal to the medial condyle of the femur. The lateral head arises from the lateral epicondyle of the femur. The medial head covers a relatively larger area than in the adult. Insertion: not worked out as yet.

M. soleus. Origin: from the shaft of the tibia in the position of the future popliteal line (i.e., from a line between the origin of the popliteus, and the origins of the tibialis posterior and flexor digitorum longus on the tibia); from the head and posterior aspect of the fibula, and from the tendinous arch between the two osseous attachments. Fleshy. Insertion: not worked out as yet.

M. plantaris. Origin: proximal to the origin of the lateral head of the gastrocnemius, from the distal and lateral portion of the planum popliteum of the femur. Fleshy. Corresponds closely to the adult. Insertion: a long tendon fused in with the tendo calcaneus. Same as the adult.

M. popliteus. Origin: mixed fleshy and tendinous from the lateral epicondyle of the femur just distal to the origin of the lateral head of the gastrocnemius. Insertion: fleshy, to the posterior surface of the upper end of the shaft of the tibia. The same as in the adult.

M. tibialis posterior. Origin: fleshy from the proximal half of the shaft of the tibia on the lateral portion of the posterior surface extending proximally to attach for a small extent on the head of the fibula; the whole extent of the posterior portion of the medial surface of the shaft of the fibula; the intervening interosseous membrane. The origin is more extensive proximally on the tibia, and distally on the fibula than in the adult. Insertion: not worked out as yet.

M. flexor digitorum longus. Origin: fleshy, from the middle three-fifths of the posterior surface of the tibia, extending more distally than in the adult. Insertion: not worked out as yet.

M. flexor hallucis longus. Origin: fleshy, from the distal two-thirds of the posterior surface of the shaft and to a slight extent from the lateral malleolus of the fibula, extending more proximally and distally than in the adult. Insertion: not worked out as yet.

OTHER MUSCLES THAN THOSE LISTED UNDER 'MYOLOGIA' IN THE B.N.A.

M. levator ani. Origin: the attachment to the posterior surface of the body of the pubis is present but is much less extensive than is shown by Spaltehols. The attachment is fleshy. Otherwise the muscle arises from the arcus tendineus M. levatoris ani in the same manner as in the adult. Insertion: not worked out.

M. ischiocavernosus. Origin: medial surface of the ischial tuberosity and the inferior ramus of the pubis. Fleshy. Insertion: not worked out.

M. transversus perinei profundus. Not found in the specimen dissected. Popowsky ('99) states that the transversus perinei is not differentiated until about the time of birth or after.

M. tensor ligamenti anularis radii volaris. Present as a small muscular slip attaching on the ulnar side of the proximal end of the radius, passing anteriorly around the radius for one-third of its circumference and inserting into the anular ligament of the radius (see fig.8, "Anomaly").

VII. Muscle Attachments in Relation to Epiphyseal Lines.

Some question has arisen as to whether or not muscle attachments ever cross epiphyseal lines, especially during the stages of development of the bones while the epiphyses are not yet fused. Investigation of this point shows that muscle attachments do cross the epiphyseal lines. It is of interest to know definitely what muscles are situated in this way; and, in the same connection, what muscles attach wholly to epiphyses without crossing the lines. The following tabulation is intended to present the data in this respect.

Muscles crossing epiphyseal lines.	Muscles attaching wholly to cartilaginous epiphyses.
Clavicle	
None	None
Scapula	
M. infraspinatus.	M. biceps brachii (both heads).
M. teres major.	M. pectoralis minor.
M. teres minor.	M. omohyoideus.
M. triceps brachii.	M. levator scapulae.
M. subscapularis.	M. rhomboideus major.
M. serratus anterior.	M. rhomboideus minor.
	M. latissimus dorsi.
Humerus	
M. teres minor.	M. supraspinatus.
M. triceps brachii (caput mediale)	M. infraspinatus.
M. subscapularis	M. anconaeus.
Common extensor tendon of the forearm.	Common flexor tendon of the forearm.
M. pronator teres.	

Radius	
M. pronator quadratus.	None.
M. brachioradialis.	
Ulna	
M. brachialis.	M. triceps brachii.
M. flexor digitorum profundus.	
M. flexor carpi ulnaris.	
M. pronator quadratus.	
M. anconaeus.	
Os coxae	
M. iliacus	M. sartorius.
M. pectineus.	M. obliquus externus abdominis.
M. obturator externus	M. obliquus internus abdominis.
M. adductor magnus.	M. transversus abdominis.
M. glutaeus maximus.	M. quadratus lumborum.
M. glutaeus medius.	M. rectus abdominis.
M. glutaeus minimus.	M. piramidalis.
M. rectus femoris (oblique head).	Larger head of the M. adductor longus.
M. gemellus superior.	M. adductor minimus.
M. ischiocavernosus.	M. adductor brevis.
M. obturator internus.	M. gracilis.
	M. coccygeus.
	M. latissimus dorsi.
	M. sacrospinalis.
	M. tensor fasciae latae.
	M. rectus femoris (direct head).

Sacrum

Since the Mm. multifidus, piriformis, and coccygeus attach each to a number of the pieces of the sacrum, they cross the epiphyseal lines. These lines have not been shown in the drawings.

Femur

M. glutaeus minimus.
M. glutaeus medius.
M. vastus lateralis.
M. vastus medialis (?)
M. adductor magnus.
M. quadratus femoris.
M. iliopsoas.
M. pectineus.
M. gastrocnemius (caput mediale)
M. plantaris.
M. piriformis.
M. obturator internus.
Mm. gemelli.
M. obturator externus.
M. gastrocnemius (caput laterale)
M. popliteus.

Fibula

M. peronaeus longus.
M. extensor digitorum.
M. soleus.
M. biceps femoris
M. tibialis posterior.

Tibia

M. tibialis anterior.
Patellar ligament.
M. poplitaeus.
M. peronaeus longus.
M. extensor digitorum longus.
M. semimembranosus.

VIII. Summary.

1. The topography of the musculature of the newborn child is not unlike that of the adult. The topography varies with the vqriations in the length, shape and size of the osseous structures, and the size of the underlying viscera.

2. In general, as far as they have been studied, the muscle attachments on the bones in the newborn are similar in position to those of the adult. Variations from the adult attachments may be explained on any of the following bases:

a. Ordinary variations from the normal such as are found in any adult body.

b. Variations due to the fact that the newborn baby is as yet incompletely developed. These cases may be simply embryological or atavistical.

The determination of the role that any or all of these factors play would require a large number of observations on a very extensive material.

3. There can be no doubt that many muscle attachments cross epiphyseal lines, thus attaching to both the diaphysis and the epiphysis. Also, many muscles attach to the cartilaginous epiphyses without crossing the epiphyseal lines./ These muscles are tabulated in the body of the paper.

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X. Explanation of Figures.

Inasmuch as there is at the present time no standard set of abbreviations for the terms used in myology, and since the terms are often of such a length as to be embarrasing in labelling figures, it has seemed advisable to work out a provisional set of abbreviations using the Basle Nomina Anatomica as a basis. The following table of abbreviations is such a set. It has been the object to reduce the number of letters of each word to the minimum and still have enough of the word present to allow one in most cases to understand what the word is signified without looking it up in the table.

In regard to the figures, the first nineteen have been made from the original bones, the outlines of which have been projected on to paper by means of a projecting apparatus made for the purpose. The muscle attachments have been drawn in with the help of measurements with a pair of proportional dividers. These figures have been made at a magnification of two. Muscle attachments are indicated in solid black; epiphyseal lines, as broken lines; capsular lines, as dotted lines. Figures 20 - 26 are photographs of the models showing the topography of the musculature of the baby.

Fig. 1. Superior surface of the clavicle.
Fig. 2. Inferior surface of the clavicle.
Fig. 3. Dorsal surface of the scapula.
Fig. 4. Ventral surface of the scapula.
Fig. 5. Lateral margin of the scapula.
Fig. 6. Dorsal view of the humerus.
Fig. 7. Ventral view of the humerus.

Fig. 8. Anterior surface of the radius and ulna.

Fig. 9. Posterior surface of the radius and ulna.

Fig. 10. Anterior aspect of the pelvis.

Fig. 11. Posterior aspect of the pelvis.

Fig. 12. Superior aspect of the pelvis.

Fig. 13. Inferior aspect of the pelvis.

Fig. 14. Lateral view of the pelvis.

Fig. 15. Medial view of the pelvis.

Fig. 16. Anterior surface of the humerus.

Fig. 17. Posterior aspect of the humerus.

Fig. 18. Anterior view of the tibia and fibula.

Fig. 19. Posterior view of the tibia and fibuba.

Models.

Fig. 20. Model I. represents a superficial dissection of the trunk musculature. The lower portions of the platysmae have been dissected away. On the left side the deep fascia of the thigh has been removed, with the exception of the tractus iliotibialis, in order to show the superficial thigh muscles.

Fig. 21. Model II. is taken from a deeper dissection of the trunk muscles. On the right side the following muscles have been removed: trapezius, deltoideus, pectoralis major, latissimus dorsi, obliquus externus abdominis; on the left side: sternocleidomastoideus, trapezius, pectoralis major, latissimus dorsi, obliquus externus abdominis, obliquus internus abdominis, rectus abdominis, glutaeus maximus.

Fig. 22. Model III. shows the deepest dissection of the trunk musculature. The upper extremities with the claviculae and scapulae have been removed together with the muscles attaching to them. The ventral abdominal wall has been cut away in part,

leaving portions of the rectus abdominis, pyramidalis, obliquus internus abdominis and transversus abdominis on the right, and remnants of the transversus abdominis, rectus abdominis (inferiorly) and the pyramidalis on the left. The right inguinal ligament has been left intact, the left one dissected away together with the cremaster of that side. The glutaeus maximus, the serratus posterior superior and inferior have been removed on the left side and the left sacrospinalis has been separated to show the iliocostalis and longissimus groups.

Fig. 23. Model V. is from a superficial dissection of the lower extremity and pelvis. The model is an extension of Model III. on the right side. Model VI. shows a deeper dissection of the muscles of the inferior extremity. The following muscles have been cut away: glutaeus maximus, tensor fasciae latae, levator ani, sartorius, gracilis, and the two heads of the gastrocnemius.

Fig. 24. Model IV. represents a superficial dissection of the muscles of the upper extremity. Most of the lacertus fibrosus has been removed. Model VII. is taken from a still deeper dissection of the lower extremity. In addition to those muscles already mentioned, the following have been removed: glutaeus medius, rectus femoris, vastus lateralis, biceps femoris, semimembranosus, semitendinosus, adductor longus, plantaris, soleus, peronaeus longus, extensor digitorum longus, tibialis anterior. The plantar fascia has been removed.

Fig. 25. Model VIII. is from a superficial dissection of the muscles of the face and neck.

Fig. 26. Model IX. portrays a deeper dissection of the facial and neck musculature. The muscles of expression have been

removed with the exception of the orbicularis oris and buccinator. The right sternocleidomastoideus and the right trapezius have been removed.

Abd.	----------	Abdominalis, Abdominis.
Abduct.	----------	Abductor.
Add.	----------	Adductor.
Al.	----------	Alaris.
Anc.	----------	Anconaeus.
Ang.	----------	Angulare.
Ani.	----------	Ani.
Ant.	----------	Anterior (-iores, etc.).
Art.	----------	Articularis.
Aur.	----------	Auricularis.
Bic.	----------	Biceps.
Bipen.	----------	Bipennatus.
Brach.	----------	Brachialis, Brachii.
Brachiorad.	----------	Brachioradialis.
Brev.	----------	Brevis (-e, -es, etc.).
Bucc.	----------	Buccinator.
Can.	----------	Caninus.
Cap.	----------	Caput, Capitis.
Carpi.	----------	Carpi.
Cerv.	----------	Cervicis.
Clav.	----------	Clavicularis.
Cocc.	----------	Coccygeus.
Colli.	----------	Colli.
Com.	----------	Communis.
Coracobr.	----------	Coracobrachialis.
Cos.	----------	Costalis, Costarum.

Crem.	----------	Cremaster.
Crus.	----------	Crus.
Cut.	----------	Cutaneus.
Delt.	----------	Deltoideus.
Depr.	----------	Depressor.
Diap.	----------	Diaphragma.
Digast.	----------	Digastricus.
Dig.	----------	Digiti, Digitorum.
Dors.	----------	Dorsalis (-es, etc.).
Dorsi.	----------	Dorsi.
Epicr.	----------	Epicranius.
Epit.	----------	Epitrochleoanconaeus.
Exten.	----------	Extensor.
Ext.	----------	Externus.
Fasc.	----------	Fasciae.
Fem.	----------	Femoris.
Flex.	----------	Flexor.
Front.	----------	Frontalis.
Fus.	----------	Fusiformis.
Gastrocn.	----------	Gastrocnemius.
Gem.	----------	Gemellus.
Geniohy.	----------	Geniohyoideus.
Genu.	----------	Genu.
Gland.	----------	Glandulae.

Glut.	----------	Glutaeus.
Grac.	----------	Gracilis.
Hal.	----------	Hallucis.
Hum.	----------	Humerale.
Iliac.	----------	Iliacus.
Iliocost.	----------	Iliocostalis.
Iliopsoas.	----------	Iliopsoas.
Inc.	----------	Incisivus (-i, etc.).
Ind.	----------	Indicis.
Inf.	----------	Inferior.
Infraorb.	----------	Infraorbitalis.
Infrasp.	----------	Infraspinatus.
Int.	----------	Internus.
Intermed.	----------	Intermedius (-ium).
Inteross.	----------	Interosseus (-i).
Intersp.	----------	Interspinalis.
Intertr.	----------	Intertransversarius (-i).
Ischiocav.	----------	Ischiocavernosus.
Lab.	----------	Labii.
Lac.	----------	Lacrimalis.
Latae.	----------	Latae.
Lat.	----------	Lateralis (-e, -es, etc.).
Latis.	----------	Latissimus.
Lev.	----------	Levator.

Lig.	----------	Ligamentum.
Long.	----------	Longus (-i, -issimus).
Lumb.	----------	Lumbalis, Lumborum.
Lumbodor.	----------	Lumbodorsalis.
Lumbric.	----------	Lumbricalis (-es).
M.	----------	Musculus.
Mag.	----------	Magnus.
Maj.	----------	Major.
Mass.	----------	Masseter.
Max.	----------	Maximus.
Med.	----------	Medialis (-e, -es, etc.).
Ment.	----------	Mentalis, Menti.
Min.	----------	Minor.
Minim.	----------	Minimus.
Mult.	----------	Multifidus.
Mylohy.	----------	Mylohyoideus.
Nas.	----------	Nasalis.
Nuch.	----------	Nuchae.
Obl.	----------	Obliquus (-um).
Obt.	----------	Obturator.
Oc.	----------	Oculi.
Occip.	----------	Occipitalis.
Omohy.	----------	Omohyoideus.
Opp.	----------	Opponens.
Orbic.	----------	Orbicularis.

Orbit.	----------	Orbitalis.
Oris.	----------	Oris.
Palm.	----------	Palmaris.
Palp.	----------	Palpebralis.
Pars.	----------	Pars.
Pat.	----------	Patellare.
Pect.	----------	Pectineus, Pectoralis.
Peron.	----------	Peronaeus.
Pir.	----------	Piriformis.
Plan.	----------	Plantaris (-es, etc.).
Plantae.	----------	Plantae.
Plat.	----------	Platysma.
Pol.	----------	Pollicis.
Pop.	----------	Popliteus.
Post.	----------	Posterior (-es).
Proc.	----------	Procerus.
Prof.	----------	Profundus.
Pron.	----------	Pronator.
Prop.	----------	Proprius.
Psoas.	----------	Psoas.
Pter.	----------	Pterygoideus.
Pyr.	----------	Pyramidalis.
Quad.	----------	Quadratus.
Quadr.	----------	Quadriceps.
Quinti.	----------	Quinti.

Rad.	----------	Radialis (-e).
Rect.	----------	Rectus.
Rhom.	----------	Rhomboideus.
Ris.	----------	Risorius.
Rot.	----------	Rotator (-es).
Sacrococ.	----------	Sacrococcygeus.
Sacrosp.	----------	Sacrospinalis,
Sar.	----------	Sartorius.
Scal.	----------	Scalenus.
Scap.	----------	Scapulae.
Semimem.	----------	Semimembranosus.
Semisp.	----------	Semispinalis.
Semitend.	----------	Semitendinosus.
Sept.	----------	Septum (-i).
Ser.	----------	Serratus.
Sk.	----------	Skeleti.
Sol.	----------	Soleus.
Sp.	----------	Spinalis.
Sph.	----------	Sphincter.
Spl.	----------	Splenius.
Stern.	----------	Sternalis.
Sternocl.	----------	Sternocleidomastoideus.
Sternocos.	----------	Sternocostalis.
Sternohy.	----------	Sternohyoideus.
Sternoth.	----------	Sternothyreoideus.
Stylohy.	----------	Stylohyoideus.
Subcl.	----------	Subclavius.

Subco.	----------	Subcostalis.
Subl.	----------	Sublimis.
Subscap.	----------	Subscapularis.
Sup.	----------	Superior.
Supin.	----------	Supinator.
Suprasp.	----------	Supraspinatus.
Surae.	----------	Surae.
Temp.	----------	Temporalis.
Tens.	----------	Tensor.
Teres.	----------	Teres.
Tert.	----------	Tertius.
Thor.	----------	Thoracis.
Thy.	----------	Thyreoideae.
Thyreohy.	----------	Thyreohyoideus.
Tib.	----------	Tibialis.
Trans.	----------	Transversus.
Trap.	----------	Trapezius.
Tri.	----------	Triceps.
Triang.	----------	Triangularis.
Uln.	----------	Ulnaris.
Unipen.	----------	Unipennatus.
Vast.	----------	Vastus.
Ven.	----------	Venter.
Vol.	----------	Volaris (-es).
Zyg.	----------	Zygomaticus.